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ABSTRACT

Research on the grammatical cues that guide comprehension of a language and that children are most sensitive to, particularly in Hebrew, is reviewed as an introduction to the first phase of a study conducted with 20 native Hebrew-speaking children aged 4 to 9 in southern California and a group of adults to provide comparative data. The study assessed the subjects' response to the competition between accusative and morphological cues in a sentence-picture correspondence task. It was found that the main effect of age could be attributed to differences between the 4-year-olds and 9-year-olds. It is also suggested that in most cases the children all trusted the accusative cues more than the morphological ones, and the oldest children trusted the causative verb pattern most while the younger trusted the reflexive pattern. Several explanations are provided for these results, including the competition theory, developmental patterns, and bilingualism effects. The second phase of the study will look at the patterns of monolingual Hebrew speakers. (MSE)

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DEVELOPMENT IN THE FUNCTIONALITY OF GRAMMATICAL CUES IN HEBREW SENTENCE COMPREHENSION

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Language users are confronted with a wealth of information to interpret. Each sentence consists of collections of grammatical cues which help make it interpretable. Since there are many grammatical cues which children could use to guide their comprehension of a language, we can ask: To which of these are children of a given age most sensitive? Perhaps, the more functional a grammatical cue is, the more often children will rely on it to interpret their language.

1. THE COMPETITION MODEL

The competition model proposed by Bates and MacWhinney (1982a, b) provides a theoretical framework for measuring the strength of the mapping of grammatical forms onto grammatical functions. Within this framework, the form that is high in validity and low in cost will be a maximally strong cue for comprehension. The model also predicts that the stronger a cue for comprehension, the earlier children will acquire it. To have high validity, a cue must be available and reliable. For a cue to be available, it must be present in every instance of its functional paradigm. For example, the passive "by" phrase is highly available, because it is present in all full passives. For a cue to be reliable, it should express a one to one mapping between form and function. Similarly, a cue is low in cost if it is detectable and assignable. For a cue to be detectable, it must be perceptually salient. An assignable cue is one that can be immediately bound to a grammatical function during processing. This simply suggests that local cues, such as, inflections, are easier to process than global cues, such as word order, as suggested by Ammon and Slobin (1979). One can determine the functionality of a grammatical cue in sentence comprehension by devising an experimental task which requires the subject to interpret sentences where cues are set in competition with one another. The manner in which subjects resolve this conflict should determine which cue is dominant in comprehension. Knowing the functionality of various cues across different languages could provide important information for crosslinguistic comparisons. For example, this information could provide a quantitative measure of the degree of "word-order-ness" of a language such as English. Further, a computational model could be developed that varied these functionality weights for different languages (for a more detailed proposal see Sokolov, 1984).

2. EXPERIMENTAL EVIDENCE FOR THE COMPETITION MODEL

Several studies have been performed which present evidence supporting the competition model. In a comparison of the cue validity of various linguistic forms across English and Italian, Bates and MacWhinney (1982b, in press) have shown that when a sentence contains competing word order and animacy cues, Italians tend to *trust* animacy cues,

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whereas Americans tend to *trust* word order cues. They suggest that this is due to the reliability of these two cues in the respective languages. Slobin and Bever (1982), armed with data from the Berkeley Cross-Linguistic Acquisition Project on Turkish, Serbo-Croatian, Italian, and English, have shown that children impose canonical schemata of word order and inflections in comprehension. They explain that in Turkish, comprehension can be based solely on inflectional markers; while, in Serbo-Croatian, comprehension must depend on an interaction between inflectional markers and word order strategies. In early stages of language development, the Turkish children performed more accurately with the accusative markers than did the Serbo-Croatian children. To explain this finding, Slobin and Bever (1982) noted that Turkish children need learn only about inflectional markers, while Serbo-Croatian children need to learn about both inflectional markers and word order cues making their task a more difficult one. In addition, Ammon and Slobin (1979) report that children who were learning inflectional languages, such as Turkish and Serbo-Croatian, performed more accurately than children who were learning non-inflectional languages, such as Italian and English. They interpreted this finding as evidence that local cues, such as inflections, require less cognitive processing than global cues, such as word order.

In Hebrew, Frankel and Arbel (1980) have shown that the Hebrew object marker, an accusative cue, is a more dominant cue for interpreting sentences than are agreement markers. They presented sentences to children between the ages of 4 and 10 which set word order, subject-verb agreement, and accusative cues in competition with one another. The results indicated that when children were presented sentences which set the object marker in competition with word order and agreement cues, the children *trusted* the object marker more than the word order and agreement cues. Since the object marker is high in validity and low in cost, this result is predicted by the competition model. They interpreted these results as suggesting that "the likelihood of assigning the agent relation to the first [versus the] second noun of Hebrew utterances systematically varied with the relative weights of cues that supported and opposed each assignment" (p. 112). These experimental manipulations provide evidence suggesting that it is possible to assess the functionality of cues in comprehension by setting grammatical cues in competition with one another.[1]

3. METHOD[2]

Most words in Hebrew have a specific root which consists of three or four consonants. Each root generally has associated with it an abstract meaning. For example, the root *l-b-S* is associated with [dressing]. To go along with these roots are verb patterns which encode different semantic relations. *Pi'el* and *hif'il* verbs generally express causative relations, which will be defined as a relationship in which one person or thing acts upon another person or thing. An example with a *hif'il* verb would be *ima hilbiSa et hayeled* "Mother dressed the boy." *Hitpa'el* verbs can, on the other hand, express reflexive relations, which

1. Although the present study and the research of Bates and MacWhinney (in press), Frankel and Arbel (1980), Ammon and Slobin (1979), and Slobin and Bever (1982) suggest methodologies for determining cue weights for grammatical rules, there is still a problem of how to account for possible interactions between cues. For example, if an experiment were designed which set in conflict cues A and B and cues A and C, but not cues B and C, would it be possible to predict whether B would be more functional than C? This approach would seem to require that every cue be specified, and tested against every other cue. Of course, this process should prove to be much more interesting than it sounds. For example, if after a comparison with B, A receives a weighting of say 0.50, and after a comparison with C, a weighting of 0.30, can we predict whether B would be more functional than C? Perhaps B and C interact in some unpredictable manner? One's initial inclination would probably be that the data concerning the interactions with A, would lead to an hypothesis that C would be more functional than B in a direct comparison.

2. Due to length restrictions, a full description of the experiment's methodology cannot be presented here; however, it can be provided upon request.

will be defined as a relationship in which one person or thing acts upon itself. An example would be *ima hitlabSa* "Mother dressed." These examples are diagrammed below in Figure 1. How is it that children come to understand and correctly use such verbs, and how important are they to the comprehension process in relation to other cues? The first question is largely answered by Ruth Berman (1980, 1981a, 1981b, 1984) who reports in a series of articles that Israeli children learn most aspects of the verb system in Hebrew by around the age of five. The present study attempts to build upon this research by answering the second question; namely, it attempts to assess the functionality of the Hebrew verb patterns in relation to other grammatical cues.

Figure 1: *Example Hebrew sentences*

$\sqrt{l-b-S}$ ⟶ [dressing] ⟶

ima	*hilbiSa*	*et*	*hayeled*
Mother	dressed+CAUS	ACC	the boy

ima	*hitlabSa*
Mother	dressed+REFL

In previous research, a picture-verification task was employed with common Hebrew verbs as stimuli to test childrens' comprehension of these verb patterns. It was unclear, however, that children who responded correctly really understood the differences between the various verb patterns. Without understanding the *grammatical rules* of Hebrew, a child might simply memorize the different verb forms and their meanings as though they were all just separate words. This presented a problem: How is it possible to distinguish a real understanding of the different verb patterns from simple rote memory for each individual verb form? One solution to this problem was to create *novel* verbs—verbs that children could not have memorized. Such verbs were formed by taking the consonantal root from nouns and forming denominal verbs from them in the sense of Clark and Clark (1979; see also Ammon, 1980, and Bolozky, 1978). For example, the verb root *p-j-m* was extracted from the noun *pajamot* "pajamas" and used to derive the transitive verb *lepajem* "to pajama" and the intransitive verb *lehitpajem* "to pajama" as diagrammed below in Figure 2.[3] All together 10 denominal verbs were derived from Hebrew nouns. If children can discriminate correctly between verb forms that they have never heard before, then it seems likely that they understand how the Hebrew verb system works.

Figure 2: *Deriving the denominal verbs*

pajamot "pajamas" ⟶ $\sqrt{p-j-m}$ ⟶ *pijem* (causative)

hitpajem (reflexive)

3. The denominal verbs were conjugated in whichever of the transitive verb patterns most preserved the morphophonology of the noun. For example, *masaxa* "mask" was conjugated in the *hif'il* verb pattern as *himsix* rather than in the pi'el pattern as *misex*.

As shown in Table 1, there was another aspect to the study as well, for verb patterns are not the only clues to meaning that are available in a Hebrew sentence. There is another important difference between causative and reflexive sentences: In causative sentences, the person or thing being acted upon is mentioned together with the corresponding object marker *et*, for example *et hayeled* in the causative sentence *aba mepajem et hayeled* "Father pajamas the boy." In reflexive constructions, on the other hand, there is no object noun. Perhaps children can understand the difference between causatives and reflexives simply by listening for the presence of these accusative cues, while paying no attention at all to the pattern of the verb. This possibility is especially important for Hebrew-speaking children who are exposed to English. Since English does not have the rich verb markings of Hebrew, a strategy of listening for nouns and their position near the verb works very well. At least for bilinguals, this kind of strategy for understanding English might *spill over* into the comprehension of Hebrew as well. To control for this possibility, children were also presented non-canonical sentences in which causative and reflexive verbs appeared alone, as well as some sentences in which causatives appeared without their object markers and objects as in *aba mepajem* "Father pajamas" and in which reflexives appeared with object nouns that didn't belong at all, as in **aba mitpajem et hayeled* "*Father pajamas [himself] the boy." These non-canonical sentences presented a kind of puzzle, in which the child had to decide which clue to meaning was the most important one, the verb pattern or competing information about the presence and absence of accusative cues.

Table 1: *Example sentence stimuli with denominal verb*

Verb Pattern	Sentence Type	Example Sentences
Causative	With Accusative Cues	1. *aba mepajem et hayeled* "Father pajamas ACC the boy"
	Without Accusative Cues	2. *aba mepajem* "Father pajamas [someone]"
	Verb Alone	3. *mepajem* "pajamas [someone]"
Reflexive	With Accusative Cues	4. **aba mitpajem et hayeled* "*Father pajamas [himself] ACC the boy"
	Without Accusative Cues	5. *aba mitpajem* "Father pajamas [himself]"
	Verb Alone	6. *mitpajem* "pajamas [himself]"

The present study is the first of two phases, the second to be conducted in Israel. Subjects in this phase were 20 Hebrew-speaking children between the ages of 4 and 9, residing with their families in Southern California. Although Hebrew was the primary language spoken in these homes and the first language of all the children, all were exposed

to at least some English, and most should be considered Hebrew/English bilinguals. The children were divided into five age groups as listed in Table 2. The age groups were formed by dividing up a chronological list of all the subjects into five groups of four children each.

Table 2: *The age groups*

Number	Group Name	Ages
4	4	4;5-4;10
4	5	5;1-5;11
4	6-7	6;8-7;1
4	7-8	7;5-8;3
4	8-9	8;10-9;1
4	A	Adult

Since other researchers have noted that the use of non-canonical sentences could produce data that are difficult to interpret, adults were also included in the study. If adults respond systematically to the stimuli, it can be argued that data from children can provide similar insight into the actual processes children use to acquire language. The adult data will also establish a base for comparison with the developmental data.

In order to assess the competition between accusative and morphological cues, a sentence-picture verification task, similar to the one used by Ammon (1980), was employed. Each set of picture stimuli consisted of a picture depicting a causative relation, a reflexive relation, a distractor, and an identifier. The actual pictures were 8 1/2 by 11 inches. The identifier picture depicted the nominal item whose consonantal root was used to derive the alternating verb patterns. A correct response for the canonical causative sentences, sentence 1 in Table 1, would be the picture depicting the causative relation. Similarly, a correct response for the canonical reflexive sentences, sentence 5 in Table 1, would be the picture depicting the reflexive relation. Each subject was presented a collection of thirty sentences, with the following instructions recited by the experimenter: "I'll show you some pictures, and then I'll say a sentence or a word. You have to choose the picture that corresponds to that sentence or word."

4. RESULTS AND DISCUSSION

4.1 THE ADULT DATA

An analysis of variance was performed which measured the percentage of adult responses which corresponded to the presented verb pattern, with verb pattern (Causative and Reflexive) and sentence type (With Accusative Cues, Without Accusative Cues, and Verb Alone) as within subjects factors. The main effects for verb pattern ($min\ F'(1,6)=10.418$, $p<0.05$),[4] sentence type ($min\ F'(2,14)=15.266$, $p<0.001$), and the two way interaction ($min\ F'(2,20)=33.313$, $p<0.001$) were all significant.

4. In accordance with accepted procedures for the statistical analysis of psycholinguistic data, the *min F'* statistic (Clark, 1973) was calculated for all the analyses of variance that were performed with both subjects and items functioning as random factors. Nevertheless, if an analysis of variance reaches significance across subjects, it will reported even if it's *min F'* did not reach significance on the basis that psycholinguistics is aimed at results that generalize across subjects.

As shown in Table 3, the adult's performed perfectly on the canonical sentences, choosing the picture that corresponded to the presented verb pattern 100% of the time. Although the causative and reflexive verb patterns played a functional role in adult's comprehension of the test sentences, this role was modulated by the presence or absence of the accusative cues. When adult subjects were presented a causative verb pattern without accusative cues, in a sentence like *aba mepajem* "Father pajamas," they chose the causative picture 95% of the time. It is clear in this case, that the presence of the causative verb pattern was a sufficient condition for a causative interpretation of the sentence. In contrast, however, when the reflexive verb pattern was set in direct competition with the accusative cues, as in **aba mitpajem et hayeled* "*Father pajamas [himself] the boy," the adults made a reflexive interpretation only 5% of the time. Clearly, then, the verbal morphology "lost" the competition in this case. The systematicity present in adult's responses to the non-canonical sentences and denominal verbs meets the requirement set earlier in the paper, and thus presents a basis for interpreting childrens' performance on the same task.

Table 3: *Percentage of choices corresponding to the presented verb pattern for adults only*

Verb Pattern	Sentence Type		
	With Accusative Cues	Without Accusative Cues	Verb Alone
Causative	100	95	75
Reflexive	5	100	100

4.2 DEVELOPMENTAL DIFFERENCES

Information concerning the children's length of stay in the United States was included as a covariate in an analysis of covariance, but did not significantly change any of the main effects or interactions, and so will not be discussed further. The effects of age (*min F'* $(5,34)=4.715$, $p<0.01$), verb pattern (*min F'* $(1,25)=5.415$, $p<0.05$), sentence type (*min F'* $(2,47)=14.712$, $p<0.001$), the verb pattern by sentence type interaction (*min F'* $(2,52)=124.098$, $p<0.001$), the age by sentence type interaction (across subjects: F $(10,36)=2.410$, $p<0.05$; across items: F $(10,90)=2.882$, $p<0.01$), and the three way interaction (across subjects: F $(10,36)=2.436$, $p<0.05$; across items: F $(10,90)=3.573$, $p<0.01$) were all significant.

The main effect of age could be attributed to differences between the the 4 year old group and the 8-9 year old group. A post hoc (*Scheffe*) analysis on the main effect of age determined that there was a significant difference between the 4 year old's and the adult's performance (F $(5,18)=3.65$, $p<0.05$), and between the 4 year old's and the 8-9 year old's performance (F $(5,18)=3.00$, $p<0.05$). Thus the 8-9 year old group made greater use of verbal morphology in responding than did the 4 year old group. At the same time, there were no significant differences within the 4 through 7-8 year old age groups. Because of this, I will henceforth refer to these groups more simply as the younger children. Just how the children interpreted the experimental manipulations will become clearer upon examination of the three-way interaction from an analysis of variance involving age, sentence type,

and verb pattern. Therefore, each frame from the three-way interaction as graphed in Figure 3 will be explained in sequence.

The effect of the accusative cues on comprehension is evident in Figure 3A. Just like the adults, the children overwhelmingly made causative interpretations whenever a sentence included accusative cues, even if the verb pattern was reflexive. Remember that these accusative cues include both the Hebrew object marker, *et*, and its object noun. These data indicate that this compound cue is very important for child and adult language comprehension, but at this stage in the research we do not know to what extent each individual cue plays a role.

Figure 3B reveals where the performance of the younger children diverged from that of the oldest children. When the younger children were presented a sentence like *aba mepajem* "Father pajamas" where a causative verb pattern is presented without accusative cues, they made a causative interpretation only 36% of the time as opposed to 80% by the oldest children and 95% by the adults. Thus, it seems that the younger children chose a causative interpretation on the basis of the *presence* of the accusative cues, not the morphological cues. Indeed the *absence* of the accusative cues may have been the signal to the younger children that the sentence required a reflexive interpretation. In contrast, the oldest children and adults assumed that when they were presented a causative verb pattern *even* without accusative cues, that accusative cues must have been intended. Thus they made a causative interpretation on the basis of the *presence* of the causative verb pattern. Figure 3C, where all the cues except the verb pattern were deleted, shows a trend similar to that of Figure 3B, differing only in the performance of the youngest children.

In sum, the results indicated that the children all *trusted* the accusative cues more than the morphological ones. However, when a causative verb pattern appeared *without* its object-marked noun but with its subject, the younger children and the oldest children performed differently. The oldest children seemed to *trust* the causative verb pattern, choosing the picture of someone acting on someone else instead of the picture of someone acting alone. It is as though they believe that the speaker intended a causative meaning but failed to mention the object. The younger children, by contrast, treat these same sentences as reflexives, choosing the picture of a person acting alone.

5. CONCLUSION

As predicted by the convergence principle of the competition model (Bates and MacWhinney, 1982a) and the prototypicality results of Slobin and Bever (1982), performance was best when *both* morphological and accusative cues led to equivalent interpretations. However, why were the accusative cues so dominant over the morphological cues? One possible explanation, as depicted in Table 4, is that the accusative cues, especially the object marker, are high in validity and low in cost, while verbal morphology in Hebrew is only medium in validity and medium in cost. The object marker is included with almost all instances of a transitive verb. This meets the availability criterion. It always marks the object. This meets the reliability criterion. Since it is perceptually distinct from the verb it follows and the object it precedes, it is also detectable. Finally, it is assignable because it marks the word it precedes. Almost the opposite is true for verbal morphology. While verbal morphology meets the availability criterion because it is always employed in Hebrew to mark semantic relations, it does not meet the reliability criterion, since the same verb pattern can mark different semantic relations. For example, the *hif'il* pattern can mark both causative and inchoative relations. Also, since verbal morphology in Hebrew is composed of a verb root *plus* a verb pattern, it isn't as detectable as the object marker. However, as an inflectional marker, it is a local cue and is therefore assignable. Thus the mediocrity of the verbal morphology as a cue helps to explain why the accusative cues "defeated" the

FIGURE 1A: THREE-WAY INTERACTION (WITH ACCUSATIVE CUES)

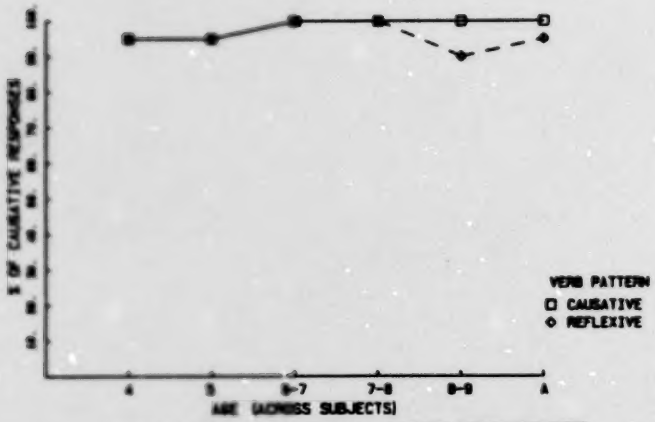


FIGURE 1B: THREE-WAY INTERACTION (WITHOUT ACCUSATIVE CUES)

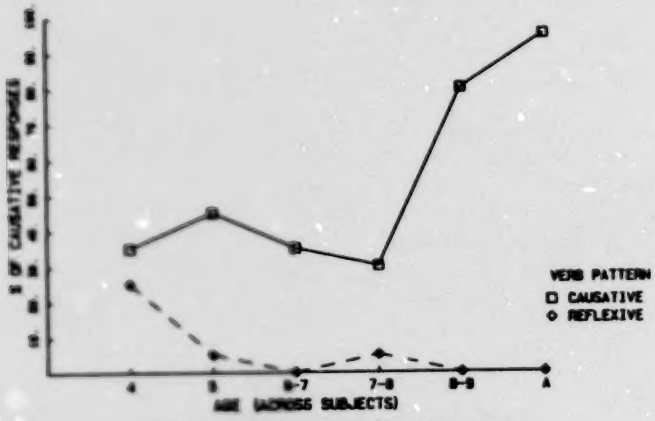
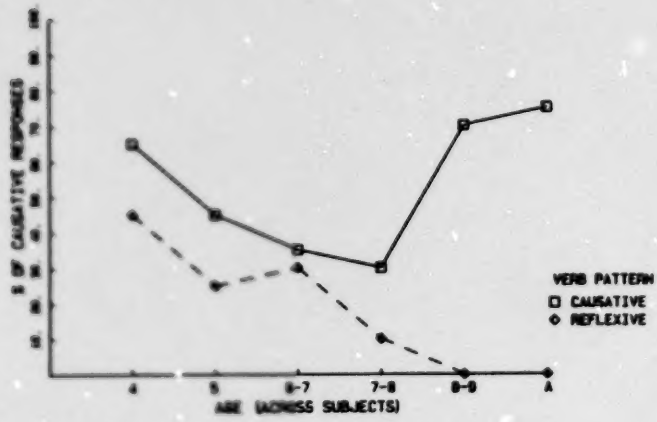


FIGURE 1C: THREE-WAY INTERACTION (VERB ALONE)



morphological cues in a direct competition. It also presents one explanation for why the younger children failed to attend to verbal morphology even in the *absence* of the accusative cues until they were around eight and nine years old. However, two additional explanations present themselves.

Table 4: *Cue validity and cue cost differences for accusative and verbal-morphological cues in Hebrew*

	Cue Validity	Cue Cost
Accusative Cues	high	low
Verbal Morphology	medium	medium

When subjects were presented a sentence with a reflexive verb pattern and accusative cues, like **aba mitpajem et hayeled* "*Father pajamas [himself] the boy," they found themselves in an unusual situation that did not correspond to any they could find in natural discourse. Thus, they were forced to make a choice between cues. Their causative interpretations indicated that they considered the accusative markers to be stronger cues than the reflexive verb pattern. However, in a sentence like *aba mepajem* "Father pajamas," where causative verb patterns were presented in the absence of accusative cues, subjects could interpret the utterance in terms of connected discourse, for it is possible that this utterance form could have occurred. In this case, it would involve ellipsis. The older children and adults listening to sentences of this form apparently assumed that some form of ellipsis had taken place, for they interpreted the individual sentences in terms of the framework of a discourse-based grammar. This explanation would correspond with the findings of Karmiloff-Smith (1982) which suggest that discourse-based grammatical rules are acquired late in development.

Another explanation derives from possible bilingualism effects. The delayed use of the verb patterns in Hebrew comprehension may result from the influence of English on Hebrew-speaking children. Since there is no system of verb conjugations in English, it is possible that the bilingual children have simply learned from English not to pay close attention to verb conjugations. Phase two of this research will attempt to answer this question by testing monolingual Hebrew speakers.

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